Contact between twins and implications for mental health.

A quantitative study on a national sample of adult twins.

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Title: Contact between twins and implications for mental health. A quantitative study on a national sample of adult twins.

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Abstact:

The relationship between twins has been described as one of the most unique and close of interpersonal bonds. Many twins maintain that being a twin is a significant influencing factor in their lives. A broad selection of psychological twin studies has been carried out with twins as methodological tools, but few empirical studies has focused at the co-twin relationship at its own right and how twins influence each other. This study seeks to examine the degree and quality of contact between twins and how it is associated with their mental health. Does a close co-twin relationship protect against poor mental health? The independent variables are six questions concerning contact, and the dependent variable is different measures of mental health (both symptoms of anxiety and depression (SCL-5 index) and personality dimensions (six personality factor scores)). The study is based on data from a national sample of adult twins (the Norwegian Institute of Public Health Twin study, N = 6662). Based on the Norwegian Birth Registry, all twins aged 18 to 31 was mailed a questionnaire. The statistical analysis used were factor analyses (PCA) and multiple regression analyses. The predictions, derived from psychological theory and evolutionary theory, were partly supported. There were significant effects, which indicates that there is an inverse correlation between co-twin contact and mental health – when contact increase, symptoms of poor mental health decrease. Perhaps contrary to evolutionary theory, few significant group differences between MZ and DZ were found.

The present study also seeks to explore whether the variables *zygosity* and *gender* moderate the effects. Are there differences between monoygotic and dizygotic twins, same-sex or opposite-sex twins, or male or female twins? The issue of causality is important to consider in relation to some of the findings, as well as practical significance versus statistical significance. The data was compared with excisting research and the theories. One practical implication of the study support for the for the notion that twins should be given opportunity to attend same class in school.

Thanks..

Thanks to my bi-supervisor Espen Røysamb (UiO) and my supervisor Kristian Tambs at the Norwegian Institute of Public Health. Kristian, thanks for sharing your extensive knowledge about twins and interest for twin research. I have learned a lot from listening to and discussing with you, and you have been enormously patient concerning my frequent questions about SPSS and statistical analyses – again and again! In addition to high quality supervision and rapid replies, I have had fun because of your great "understatement" sense of humor.

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Contact between twins and implications for mental health

We are all dependent of our social relationships. Among twins, the co-twin is most likely a particularly important source of affection. The relationship between co-twins has been described as one of the most unique and intimate of all interpersonal bonds (Burlingham, 1963; Koch, 1966; Neyer, 2002b; Segal, 1997; Woodward, 1998). Many twins maintain that being a twin is one of the most significant influencing factors in their lives (Ainslie, 2005). A broad selection of psychological studies that involve twins has been carried out - since the "twin method" was established, scientific research has employed monozygotic/identical (MZ) and dizygotic/fraternal (DZ) twins as methodological tools ascertaining the relative influence of nature and nurture (Bacon, 2005). However, few psychological twin studies have examined the relationship between twins on its own right. The effects of the relationship has been of great interest to relatives of twins, as well as the popular literature and movies, but has received lesser empirical research attention (Penninkilampi-Kerola, 2006, Trias, 2006, Tancredy & Fraley, 2006). Consequently, little is known about the implications growing up as a twin may have on interpersonal psychological issues (Rutter & Redshaw, 1991).

Further, the existing literature seems divided in terms of describing twinship as being positively or negatively related to personal development and mental health. In several famous and often quoted twin studies the very fact of being a twin, regardless of zygosity, is discussed as a potential threat to personality development and mental functioning (Burlingham, 1952; Hartmann, 1958; Arlow, 1960; Leonard, 1961; Siemon, 1980: Ainslie, 1997). An alternative view is rooted in the notion that twinship may form an advantageous social environment and provide important social support (Torgersen, 2004, Koch, 1966; Pulkkinen, Vaalamo, Hietala, Kaprio & Rose, 2003). A study by Paluszny, Selzer, Winokur and Lewandowski (1977) has found negative correlations between the closeness of twins and depression. A reduced suicidal risk has been found in twins compared to singletons (Tomassini, Juel, Holm, Skytthe & Christensen, 2003).

Pulkkinen and colleagues (2003) comment on this diversity in twin research, and place the approaches that focus on the disadvantages of being a twin within the perspective ***the psychopathological hypothesis.*** The alternative perspective, which is rooted in the notion that twinship may form an advantageous social environment and provide important social support, is called the ***the adaptive hypothesis***. These views represent competing foci on the consequences of being a twin.

In addition to focus on negative or positive effects of twinship, the research on twin relationships can be categorized according to their theoretical approaches. Psychodynamic, evolutionary psychological, behavioural-genetic and social-genetic theories are the dominating frames of explanation (Segal, Herschberger & Arad, 2003). The psychodynamic approach has focused on questions concerning developmental issues and identity formation, and concentrated on how twins rearing environment sets them apart from singletons. The evolutionary psychology perspective has focused on studying mechanisms of the co-twin relationship in the context of natural selection and shared genes, and has explored the differences between MZ and DZ twins related to promoting the reproduction and survival of the genetic inheritance of the individuals' own genes (Penninkilampi-Kerola, 2006).

In the present study we choose to focus on evolutionary psychological theory and attachment theory. When using more than one theoretical approach, it is common to choose theories that contradict each other. These two theories can be categorized into different levels of explanation, but still be integrated with each other. They may be seen as a genetic and a relational perspective which offers predictions that overlap concerning co-twin contact and mental health. In the present study, evolutionary psychological theory and attachment theory are viewed as complementary to each other, and a useful and relevant framework in order to describe and examine twin relationships.

Evolutionary psychological theory

Why this theory is considered relevant for describing and examining twin relationships, is closely linked to Hamilton's (1994, in Segal, 1999) concept *inclusive fitness*. He formulated a hypothesis where Darwin's (1859) notion of *natural selection* is not only about the reproductive success of the individual, but the replication of the genes of the individual as they exist in relatives. This view on behaviour that focused on genes rather than the person carrying them brought about a new way of thought in respect of predictions about human behaviour – especially helping behaviour, often referred to as *altruism* within this theoretical approach. Altruism is described as unselfish behaviour, or the interest in other people's well-being, defined as behaviour that results in the assistance of others *on the actor's expense.* A central notion within evolutionary psychology is that biology influences the way we behave toward each other (Segal, 1999, 2005; Segal, Weisfeld & Weisfeld, 1997). According to this theory, MZ-twins, who share 100 % of their gene pool, are supposed to be more mutually helpful than DZ-twins, who share 50 % of the gene pool. DZ-twins and siblings are supposed

to be more mutually helpful than cousins, who share 12,5 % of their gene pool, and cousins are expected to be more helpful to each other than people who are unrelated. The rationale is that by helping a twin, sibling or other relatives, opposed to non-kin, you help yourself – by ensuring the survival of you own genes. How genetic kinship is translated into behaviour, is not yet clear (Segal, 1999). Nor is it given how the principal of kin selection is associated with twins' mental health, but a "common sense" assumption is that altruistic behaviour is beneficial for mental health, and protects against symptoms of anxiety and depression and development of a maladjusted personality.

According to evolutionary psychological theory the bond between twins may be interpreted in terms of genetic relatedness, and therefore differences between twin pairs due to their zygosity is stressed. Segal (1999, 2005) has found in her studies that MZ-twins share closer bonds than DZ-twins, and calls their bond "friendship extraordinaire". Neyer (2002) has demonstrated that emotional and residential closeness, contact and support have been shown to be more profound in MZ than in DZ twin pairs throughout adult life. He argues that MZ twins more often choose each other as close relationship partners, and this shared and similar environment will most likely lead to increased contact and increased intensity of the relationship. The twinship may be understood as an interplay between genes and environment, usually termed as an active, passive and evocative effect. Both with MZ and DZ twins the twinship is predetermined at birth (passive effect). Over the life course MZ twins are more likely than DZ twins to choose their co-twin as a close relationship partner (active effect), and simultaneously they are more likely to be chosen by their co-twin (evocative effect).

Neyer suggests that MZ twins are more likely to search for similar environments, while DZ twins are more likely to seek out different environments through the life course. This may lead to a increased contact and higher closeness of the twin relationship among MZ than DZ twins. With the evolutionary psychological model as a base, one may predict that genes shared with close relatives are helped to survive since a close bond between relatives (twins) is rewarded by adaptation (good mental health). Strong mental health may well cause increased reproduction and will be helpful in taking care of own as well as the co-twin's offspring. A second prediction is that the quality of the twin relationship depends on zygosity status.

Attachment theory

The ethological theory of attachment has evolved from the psychodynamic paradigm, and offers a different relational approach in explaining interpersonal relationships than the classic psychodynamic/psychoanalytic perspectives (Trias, 2006). A growing body of twin research argue that attachment theory offers a useful framework for understanding the nature of twin relationships (Tancredy & Fraley, 2006; Penninkilampi-Kerola; 2006, Trias; 2006, Neyer, 2002). However, twins' attachment to their parents, and how this relationship affects them, is beyond the scope of this study - here the focus is behaviour related to attachment between adult twins. Bowlby (1969, 1973) argued that the attachment of an infant is formed through a repertoire of genetically founded behaviour which gradually matures and is directed towards the primary care person. He emphasised the active element of attachment behaviour, as a contrast to a passive dependence concept. Where other development theories describe dependence as inevitable during infancy, regressive and unwanted in later years and without biological value, Bowlby viewed attachment behaviour as an essential part of human "behaviour equipment" where security and protection are biological functions, and where the child creates an inner working model of the relation (Bowlby & Ainsworth, 1991).

Ainsworth (1969) empirically tested the theory, and defined three types of attachments, where one type was classified as secure and two as insecure. An attachment relationship is characterised by four criteria which separate it from other close relationships: attachment behaviours as it manifest itself in desire for *proximity seeking/maintenance, separation distress, safe haven and secure base* (Bowlby, 1969, 1973; Ainsworth, 1969). Studies support the assumption that attachment in adulthood is analogous with that of infancy (Tancredy & Fraley, 2006, Hazan & Shaver, 1987, 1990). One of the important aspects of attachment theory is therefore the assumption that dependence directed toward a sensitive, reliable and responsive significant person is crucial for best possible mental health from cradle to grave (Bowlby, 1969, 1973, 1988). Tancredy and Fraley (2006) reviewed various studies in order to compare the behaviour of twins with the criteria that characterise attachment behaviour. These studies indicate that twins (both MZ and DZ twins) amongst each other have a behaviour which is analogue to what Bowlby and Ainsworth described as attachment behaviour, and that the relationship between twins often is of such a nature that it qualifies for being defined as an attachment relationship. In addition, data from their own study demonstrate that adult twins to a higher degree than singleton siblings regard their twin as an attachment figure, place their twin on the top of their attachment hierarchy, and that they regard their parents as attachment

figures to a lesser degree than singletons. In contrast to the evolutionary psychological approach, neither the DZ nor the MZ twin relationship is seen as qualitatively different from all other types of relationship, but rather as an attachment relationship in line with other attachment relationships (Tancredy & Fraley, 2006).

Attachment theory emphasises relations to significant others as crucial for mental functioning, and twins seem to be significant to each other in most cases. An attachment model used on adult twins hypothesizes that the overall quality of the relationship to the co-twin is an important determinant of mental functioning. According to this theory we can predict a positive correlation between the quality and closeness of the co-twin relationship and subjective mental health. As stated above, differences co-twin closeness between MZ and DZ twins is a clear prediction from the evolutionary approach. But differences between MZ and DZ twins also seems to be a reasonable extension of the attachment theory: if there is a secure attachment between twins, which perhaps overshadows the attachment to other family members, this may be due to the twin relationships facilitation of an attachment relationship (i.e. shared experiences, common interests and opportunities to be together). Because they are genetically identical, MZ co-twins are more likely to communicate well and share interests than do DZs. In conclusion, a very close relationship is more likely between MZ than DZ twins.

Aim of the study

This study will investigate this research questions derived from the theories in a national sample of 6662 adult twins:

- Does a close co-twin relationship protect against mental health problems? I.e., do the measures of the co-twin relationship (frequency and quality of contact) predict good mental health (negative symptom ratings of anxiety and depression, and negative scores on a number of personality dimensions)?

The study also seeks to examine whether the variables zygosity and sex moderate the results. Are there differences between the categories of twins in effects of contact on mental health? (Abbreviations: Monozygotic = MZ, Dizygotic = DZ, Same-sex dizygotic = SSDZ, Opposite-sex dizygotic = OSDZ, Monozygotic males = MZM, Monozygotic females = MZF, Dizygotic males = DZM, Dizygotic females = DZF).

Method

Participants/sample

This study is based on data from the Norwegian Institute of Public Health Twin Study; which was collected in Norway in 1998-1999. This is a longitudinal twin study with a cohort sequential design (Nes, 2007). Based on the Norwegian Birth Registry, comprising all births in Norway since January 1, 1967, a total of 12,700 same sex and male/female pairs of twins aged 18 – 31 were mailed a questionnaire. Responses were obtained from 8,045 subjects, comprising 3,334 complete pairs and 1,377 singletons, representing a response rate of 63 % for individual twins and a pair-wise response rate of 53%. This data collection was a follow-up and expansion of a corresponding survey from 1992, in which a total of 5, 864 twins aged 18-25 participated. 59 % of the 6,660 twins (full pair) from the 1999-study also participated in the 1992 survey. The number of complete pairs was 526 monozygotic (MZ) males, 397 dizygotic (DZ) males, 777 MZ females, 655 DZ females and 979 DZ pairs of opposite sex (OSDZ). The twins were divided into groups when coded before for statistical analyses:

- Group 1: MZ males
- Group 2: DZ males
- Group 3: MZ females
- Group 4: DZ females
- Group 5: OSDZ males and females

SPSS for Windows, Version 12, was used in all the analyses.

Zygosity:

Zygosity was determined on the basis of seven questions previously validated to correctly categorize 97 % of the twins (Røysamb, Tambs, Reichborn-Kjennerud, Neale & Harris, 2003). Subsequently, twenty-four micro-satellite markers were genotyped on a sub-sample of 676 of the same-sex pairs in the sample, and results from these markers were used as a dependent variable in a discriminant analysis with the questionnaire items as independent variables. Some of the pairs with DNA information were found to be misclassified by the questionnaire items, and was therefore corrected. The total number of expected misclassified

pairs could be estimated as 2.51 % of the same-sex pairs of questionnaire based zygosity, and this number corresponds to a misclassification ratio of 1.38 % of the total sample (Nes, 2007).

Measures

The twin relationship:

How to measure a bond or connection between twins? Some authors argue that the research tradition lacks a uniform conceptualization of the characteristics of co-twin relationships, and different constructs has been used in order to describe it (Tancredy & Fraley, 2006, Penninkilampi-Kerola, 2006, Trias, 2006). The relationship between twins has been named according to the theoretical frames of reference. Often distinctions between concepts can be made only conceptually, and are likely to be related to each other within subjects (Neyer, 2002; Neyer, Banse & Asendorpf, 1991). In the present study, the core concepts of the theories used are "*attachment"* and "*altruism"*. Six questions from the Norwegian Institute of Public Health Twin Study questionnaire who measured quality and degree of contact was used to assess these concepts, i.e. the co-twin relationship (Tambs, Harris & Magnus, 1995): *frequency of personal contact*, *frequency of telephone contact*, *perceived closeness during life*, and *years sharing the same class at school*, *age when moved from childhood home* and *distance between residences.* Question number three, *perceived closeness*, is probably the one closest connected to the concept of "*attachment*". Years together in same class and in childhood home reflect factors influencing degree of contact during childhood and adolescence primarily beyond the twins' control. The contact variables were used as independent variables in the regression analysis (Table 1).

Table 1 Questions meant to assess the degree and quality of the co-twin relationship (Independent variables)

Items	Coding format
1. How often have you had contact with your twin the last year? - Telephone contact (telconp)	1=each day, 2=1-3 times per week, 3=1-3 times per month, 4=7-12 times a year, 5=1-6 times a year, 6=less than 1 time per year
2. How often have you had contact with your twin the last year? - Face-to-face contact (perconp)	1=each day, 2=1-3 times per week, 3=1-3 times per month, 4=7-12 times a year, 5=1-6 times a year, 6=less than 1 time per year
3. Perceived closeness to co-twin during lifetime (compared to singleton siblings) (godconp)	1=poorer, 2=the same, 3=a little better, 4=much better
4. Did you and your twin attend same class, and in that case, how long? (yrsclp)	1=nei, 2=ja (number of years)
5. How many years in sum have you and your twin been living together? (yrtogp)	(number of years)
6. How far in distance is it between you and your twin's residences? (distp)	1=same, 2=0-100 m, 3=100 m-1 km, 4=1 km-1 mil, 5=1 mil-10 mil, 6=more than 10 mil

Mental health:

In the present study, the aspiration was to measure mental health in a broad sense. Therefore the mental health measures consist of items meant to tap both symptoms and personality dimensions related to mental health problems. The measures chosen as dependent variables were an index with five items related to symptoms of anxiety and depression (SCL-5) and six personality factors based on a pool of personality items.

Measuring mental health through symptoms of anxiety and depression (SCL-5 index):

The five items in the SCL-5 are taken from the Symptom Check List (SCL-25) by Hesbacher, Rickels, Morris, Newman & Rosenfeld (1980); witch is regarded as a useful instrument for measuring global mental health (Table 2). SCL-25 has two dimensions designed to tap anxiety and depression (Tambs et al., 1995). In social science studies with a broad scope, such as the Norwegian Institute of Public Health Twin Study, there is often a need to collect information of mental health. There was also a need for limiting the length of the questionnaire, for several reasons. The solution was to use a sum of five questions from the SCL-25 anxiety and depression subscale, which correlates at r = 0.92 with the global SCL-25 score and an alpha reliability of 0.85 (Tambs & Moum, 1993). These results demonstrate psychometric properties well within what is required for the present purpose.

Table 2 SCL-5 items and coding format

Items	Coding
1. Feeling fearful	1 = not at all, 2 = a little, 3 = quite a bit, 4 = extremely
2. Feeling tense or keyed up	
3. Feeling hopeless about the future	
4. Feeling blue	
5. Worrying too much about things	

Measuring mental health through personality dimensions (the six personality factors)

188 items intended to measure personality and personality disorders, proposed by Svenn Torgersen, UiO, were included in the questionnaire. These data were subject to a principal component analysis (PCA). An oblique solution was chosen, implying that each factor (dimension) was allowed to correlate with the other dimensions. Prior to this, the suitability of data for factor analysis was assessed. The correlation matrix revealed presence of many coefficients of .3 and over. A large number of solutions with varying numbers of components were tried out. The solution which included twelve components seemed to produce the most

preferable pattern, i.e. high loadings on each component and a low degree of cross loadings (Pallant, 2005). The shared explained variance was 39.3 per cent for all the components in sum. Then six of the twelve components judged to be closest related to mental functioning were chosen for further analyses (Table 3):

1. Insecurity concerning self esteem and feeling of identity.
2. Extroversion.
3. Negative emotions.
4. Economical skills/control in use of money.
5. Susceptibility.
6. Social inhibition and withdrawal.
7. Sensation seeking.
8. Lack of reality orientation.
9. Emotional instability.
10. Difficulties in forming and maintaining close relationships.
11. Neatness/tidiness.
12. Tendencies to keep feelings hidden.

Table 3 The six personality factors (based on questionnaire items) and factor loadings

Factor 1 Insecurity concerning self esteem and identity	**Factor loading**	**Factor 3 Negative emotions (reversed)**	**Factor loading**	**Factor 6 Social inhibition/ withdrawal**	**Factor loading**	**Factor 8 Lack of reality orientation**	**Factor loading**	**Factor 9 Emotional Instability (reversed)**	**Factor loading**	**Factor 10 Difficulties concerning close relationship**	**Factor loading**
Sometimes I feel that I am good for nothing	.651	I do not easily get angry	-.703	I decided long ago that it was best to have little to do with others	.587	Sometimes I get strange ideas in my head that I cannot get rid of	.593	My emotions are fairly well balance	-,634	I feel trapped when I have a relationship	.633
My lack of self-confidence can sometimes be a problem	.612	I very seldom get upset	-.666	In social settings I feel tense and inhibited almost all the time	.575	I am not sure whether voices I have heard or things I have seen are just fantasy or reality	.576	Because my emotions change rapidly, It is often difficult for me to keep a steady course	.513	I am afraid of close relationships	.555
It often seems like other people do everything much better than I do	.575	Some of the people that know me think that I am rather aggressive	.598	I have always tried to avoid social gatherings	.549	I am not sure whether certain impressions are real or if I just imagine things	.560	I keep both feet on the ground. I stick to what is tangible rather than be lost in reverie	-.489	People have a tendency either to overwhelm me with affection or leave me	.504
Periodically I keep thinking that nobody really cares about me	.524	I express my feelings freely when I am angry	.566	Somehow I feel It is hard for me to know how I should behave among other people	-.527	I have seen or heard things that have no logical explanation	.518	On the average, I am calm and even-tempered	-.458	People that seem all right to begin with, often wind up disappointing me	.478

I am very touchy about criticism	.517	I often get too agitated, even when it comes to trivial matters	.545	I have always had long periods in my life when I hardly speak to anyone	.470	I am often not able to tell what I am going to do the next minute	.478	My reactions are mainly determined by emotions rather than reason	.405	I feel that my needs are not met	.456
I feel uncertain about my identity as a man/woman	.514	I get all worked up when the situation justifies it	.472	It is hard for me to maintain friendship	.460	I feel as if I watch myself put on an act	.475	My mood will easily change in accordance with the environment	.392	I have been involved in relationships where I was unable to identify whether thoughts and emotions belonged to me or the other person	.418
I am not sure what people think about me, even if they know me very well	.501			People treat me as if I were an "object"	.423	I believe that things can happen just by thinking about them	.468			Many people have pried into my private life for years	.405
I sometimes feel that nobody wants to have anything to do with me	.489					I can do things that make people feel upset but I cannot understand why they feel that way	.445			I behave in a way that that people consider as unexpected or changing	.399
I easily get hurt if someone ridicules me or makes derogatory remarks	.481					My emotions sway extremely. I am either very happy or very depressed	.437			It is difficult for me to trust people, since they very often turn their backs on me or let me down	.380

Sometimes I have the intense, uncomfortable feeling that I am different from everybody else	.463	I sometimes feel that I have my head in the clouds	.433
I wonder who I really am	.429	I often feel that I pretend so that people see me as a very changeable person, depending on time and place	.374
I do not brood over other peoples remarks	-.420	I feel as if I am a different person from one day to the next	.373
Normally I feel confident and secure, even in new and unfamiliar situations	-.392		

Measuring twins as dyads:

In this study the relational dyad - that is, the pair - was chosen as analysis unit rather than two individual persons. This approach in measuring twins is supported by Neyer (2002a, 2002b), who states that partners are likely to reciprocate each other's need for attachment with care giving behaviour in an adult attachment relationship, and that attachment related behaviours are highly interdependent between dyad members. All the variables used in the analyses in this study, both independent and dependent, are made by dividing the sum of both means by two. If there were only one valid value for the first twin of the pair, this value was used as mean for the pair, and conversely if only the second twin had a valid value. The following is an example of an SPSS-command (for the variable *personal contact*, "percon2" (the value of the first twin in a pair), percon2t (second twin), and perconp (mean pair value)):

if (percon2 ge 0 and percon2t ge 0)perconp=(percon2+percon2t)/2.
recode percon2 percon2t(sysmis=-9).
if (percon2 ge 0 and percon2t=-9)perconp=percon2.
if (percon2=-9 and percon2t ge 0)perconp=percon2t.
recode percon2 percon2t(-9=sysmis).

Missing data and imputation:

Pair means were used where both twins had complete data. If data from one twin were missing or invalid, data from the co-twin were used to establish mean values. Missing data for the items in both twins were substituted with mean values in each sex and zygosity group.

- *Contact variables*. If both the twins had missing invalid responses on the same questions, the twin pair was excluded from the analysis.
- *SCL-5:* Each item for the respondent was imputed if there were 3 or more valid values and respondents with 2 or less valid values was entirely excluded from the analysis.
- *The personality items:* Every item was imputed if more than 2/3 of the 188 personality items were valid. Respondents who had 1/3 or less valid responses were excluded from the analysis.

Missing data were imputed using the imputation procedure MVA, option EM in SPSS.

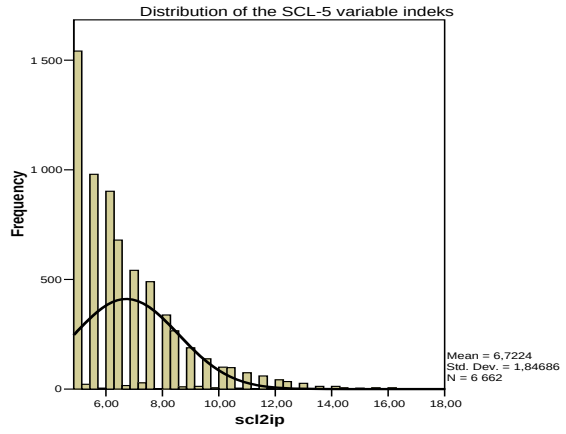
Items/variables reversed:

The items or variables varied in how they were phrased as questions in the questionnaire, and how they were scaled in the coding process. After reversion of three of the contact variables and two of the factors, all the negative (or inverse) correlation coefficient values indicate support of the research question. This makes the tables easier to read and the correlations comparable. The reversed items are *telephone contact*, *personal contact* and *distance* (independent variables), and *negative emotions* and *emotional instability* (dependent variables).

Transforming data:

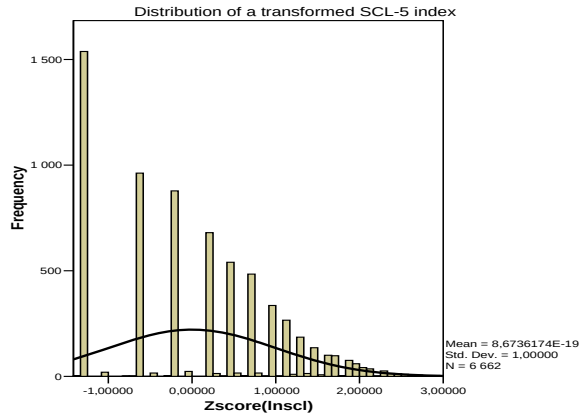
When checking the distribution of the scores on the variables (Figure 1), we found that the scores on one of the dependent variables (symptoms of anxiety and depression, the SCL-5 variable) were strongly positively skewed, meaning that most of the twins record low scores on this items (low scores indicates low degree of symptoms).

Fig.1 SCL-5 index (dependent variable) distribution before transformation



This is quite common when it comes to measures of depression. Given that the multiple regression analyses (and other parametric statistical test) assume normally distributed scores on dependent variables, one alternative is to transform the variables, which means to mathematically modify the scores using a formula until the distribution looks more normal (Pallant, 2005; Howitt & Cramer, 1995; Cozby, 2001). A new variable was produced through a logarithmic transformation of the SCL-5 index in SPSS (compute lnscl=ln(scl1ip-4) (Figure 2). This command transformed the distribution to a more normal one.

Fig. 2 SCL-5 index (dependent variable) distribution transformed



This form of transformation was only conducted on this dependent variable (SCL-5), not on the other dependent variables (the six personality factors) because they were more close to normal distribution.

Standardization:

All the dependent variable (SCL-5 and the factors) values were converted into standardized (z) scores. Example from command in the SPSS syntax (SCL-5): desc lnscl(zlnscl)).

Statistical method

Initially, an exploratory factor analysis was conducted to explore the underlying structure of the items in the personality scale and choose factors relevant for mental health measuring. In order to predict scores on mental health (dependent variable) from scores on the six contact measures (independent variables), a standard multiple regression model was chosen (Allison, 1999; Undheim, 1996). Multiple regression analysis was also used testing differences in effects of contact between zygosity groups and sexes. *Zygosity X contact* and *sex X contact* interaction terms were generated and entered in the regression models.

Example from syntax:

Initially, the zygosity groups (1-5) had to be recoded. When comparing MZ with SSDZ twins: recode group05 (1, 3=1) (2, 4=2) into *zygosity*. When comparing MZ + SSDZ with OSDZ: recode group05 (1, 2, 3, 4=1) (5=2) into *zygosity2*.*Contact and zygosity* interaction effects: compute *telxzyg=telconp*zygosity* (same procedure for all the six contact variables).*Contact and gender* interaction effects: compute *telxzyg2*=telcon**zygosity2*. *Contact and sex* interaction effects: compute *telxkjønn=telconp*kjønn*.

Results

Table 4 Means and standard deviations for the contact (independent) variables

	N	Minimum	Maximum	Mean	Std. Deviation
Telephone contact	6360	1,00	6,00	2,2870	,86066
Personal contact	6534	1,00	6,00	2,7343	1,35393
Closeness	6658	1,00	4,00	3,0601	,79711
Years same class	6496	1,00	19,00	9,3533	2,11537
Years living together	6654	,00	29,00	18,9539	2,29959
Distance	6660	1,00	6,00	4,2267	1,67735

Does a close co-twin relationship protect against mental health problems?

To examine whether a co-twin relationship protects against poor mental health, the six contact variables were used as independent variables and the SCL-5 index variable and the personality dimension measures (factors) were used as dependent variables in regression models. All the contact scores were scaled in a way that high values indicate high degree of contact and the effect variables in a way that high values indicate poor mental health. The analyses were carried out separately on the different categories of twins (MZ, SSDZ and OSDZ) because of the theory driven assumption that the effects may vary with zygosity status.

Symptoms of anxiety and depression (SCL-5): In MZ and SSDZ twins, respectively 3,8 % and 5,5 % of the variance in anxiety and depression scores can be explained by sex. Explained variance increases to 5,7 % and 7,2 % when the contact variables are added in the analyses. In OSDZ twins (were the influence of sex is constant) 3,5 % of the variance in the symptom scores can be explained by the contact variables. There are significant effects of the contact variables in all groups (Table 5).

Table 5 Effect of contact between twins on symptoms of anxiety and depression (z-transformed SCL-5)

Contact	**MZ** (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictors	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	.040	.027	.251	**.106 (.04 - .18)**	**.087 (.03-.14)**	**.003**	-.061	-.058	.063
Personal contact	.028	.037	.248	-.005	-.007	.867	.007	.010	.803
Closeness	.043	.027	.208	**-.070 (-.13 - -.01)**	**-.055 (-.10- -.01)**	**.024**	.011	.009	.733
Years same class	**-.048 (-.07- -.03)**	**-.109 (-.14 - -.06)**	**.001**	-.022	-.042	.062	**-.030 (-.05- -.01)**	**-.059 (-.11- -.01)**	**.015**
Years liv. tog	**-.028 (-.05- -.01)**	**-.065 (-.11 - -.02)**	**.002**	**-.052 (-.07- -.03)**	**-.113 (-.16- -.07)**	**.001**	**-.077 (-.10- -.05)**	**-.163 (-.21- -.11)**	**.001**
Distance	-.026	-.045	.134	.017	.027	.430	.005	.008	.819
Adjusted R Square	(Sex only):.038 (Sex+contact):.057			(Sex only):.055 (Sex+contact):.072			.032		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "mental health symptoms (Scl-5)", adjusted for gender. 95 % Confidence Intervals in parentheses.

The largest standardized coefficient (beta value) is for *years in same class* for MZ twins and *years living together* for SSDZ and OSDZ twins. This means that these variables make the strongest unique contribution in predicting the dependent variable, when the variance explained by the other contact variables and sex is controlled for. In sum, the contact variables are making a statistically significant unique contribution to the variance seven times for the three groups.

All coefficients are in the expected negative direction, except one, *telephone contact*, which reaches significance in the SSDZ group. This indicates that symptoms of anxiety and depression increase when telephone contact increases. The symptoms decrease when *years in same class, years living together* and *closeness* increases. The beta values tell that for each standard deviation (SD) increase in *years in same class*, the anxiety/depression symptoms on average decrease with 0.109 SD among MZ twins. The unstandardized regression coefficient, b, shows that the expected decrease for each year extra in class together is 0.048 of a standard deviation, or, in other words, the expected difference in symptoms of anxiety and depression between MZ twins having spent no time together and having spent 10 years together in same class is 0.48 standard deviations.

The personality dimensions: In addition to symptoms of anxiety and depression this study aims to investigate effects of co-twin contact on personality related scores (*insecurity concerning self esteem and feeling of identity, negative emotions, social inhibition and withdrawal, lack of reality orientation, emotional instability, difficulties concerning close relationships*). As with the symptom scores, the six personality factors were subject to linear multiple regression analysis with the contact indicators (controlling for sex in the MZ and

SSDZ groups) as predictors (Table 6-11). In all analyses at least one effect reached statistical significance at the .001 level, except *emotional instability* (Factor 9), on SSDZ twins (Table 10), in which the significant level for *years in same class* was 0.013. The proportion of variance in the personality functioning that can be explained by the contact variables in addition to sex varies from .1% (SSDZ twins, Tables 6) to 3.5% (MZ twins, Table 7) for same-sexed twins. The proportion of variance that can be explained by the contact variables in OSDZs varies from .6% (Table 10) to 4.2% (Table 8).

The best predictor, i.e. the independent contact variable that has the strongest relative contribution for all the personality factors in all three twin groups, are *years living together* and *years in same class* which out of 18 possible reaches statistical significance 16 (*years living together)* and nine times *(years in same class)*. In sum, there are 48 significant beta values, and the direction of the probability values is both positive and negative though there are most negative correlations (Table 6-11 and Table 12-13, a+b). Thus, in general frequency and closeness of contact between twins correlates negatively with poor mental health. However, there are some exceptions, and one of the frequent appearing effects is related to *personal contact, telephone contact* and *distance* (Table 12-13, a+b). Different forms of difficulties in mental health and personality functioning seem to increase in relation to these forms of contact in some twins.

Table 6 Effect of contact between twins on insecurities concerning self esteem and identity (Factor 1)

	MZ (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictos	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	-.009	-.008	.740	.004	.004	.882	**.056 (.01-.12)**	**.072 (-.19- -.01.01)**	**.022**
Personal contact	.004	.007	.820	-.006	-.011	.773	-.01	-.018	.662
Closeness	**-.057 (-.11- -.00)**	**-.044 (-.08- -.00)**	**.036**	.004	.004	.873	.015	.016	.539
Years same class	-.007	-.019	.343	.002	.006	.799	-.014	-.036	.139
Years liv together	**-.020 (-.04- -.01)**	**-.056 (-.10- -.02)**	**.006**	-.003	-.008	.736	**-.041 (-.06- -.02)**	**-.118 (-.17- -.07)**	**.001**
Distance	-.020	-.027	.344	.020	.041	.207	-.002	-.005	.884
Adjusted R Square	(Sex only):.129 (Sex+contact):.131			(Sex only):.135 (Sex+contac): 136			.017		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "insecurities concerning self esteem and identity", adjusted for gender. 95 % Confidence Intervals in parentheses.

Table 7 Effect of contact between twins on perceived negative emotions (Factor 3)

	MZ (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictors	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	**.128 (.07-.18)**	**.108 (.06-.15)**	**.000**	.002	.002	.940	-.005	-.007	.832
Personal contact	.013	.022	.491	**.055 (.01-.10)**	**.096 (.02-.17)**	**.012**	**.056 (.01-10)**	**.102 (.02-.18)**	**.014**
Closeness	-.035	-.027	.198	**-.048 (.00-.09)**	**-.049 (-.10- -.00)**	**.041**	-.039	-.040	.124
Years same class	**-.025 (-.04 - -.01)**	**-.071 (-.26- -.03)**	**.001**	-.017	-.041	.065	**-.025 (-.04 - -.01)**	**-.067 (-.12- -.02)**	**.006**
Years liv together	**-.040 (-.05 - -.03)**	**-.114 (-.16- -.07)**	**.001**	**-.036 (-.02-.05)**	**-.102 (-.15- -.06)**	**.001**	**-.050 (-.07 - -.03)**	**-.140 (-.19- -.09)**	**.001**
Distance	**.029 (.00-.06)**	**.063 (.01-.12)**	**.031**	.019	.039	.236	.028	.061	.091
Adjusted R Square	(Sex only):.055 (Sex+contact):.090			(Sex only):.082 (Sex+contact):.105			.039		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "perceived negative emotions", adjusted for gender. 95 % Confidence Intervals in parentheses.

Table 8 Effect of contact between twins on social inhibition and withdrawal (Factor 6)

	MZ (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictors	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	-.007	-.007	.781	-.042	-.046	.127	**-.081 (.03-.13)**	**-.096 (-.16- -.04)**	**.002**
Personal contact	-.017	-.030	.353	.002	.004	.916	**.089 (-.04- -.14)**	**.155 (.07-.24)**	**.001**
Closeness	.001	.001	.987	**-.083 (-.13- -.04)**	**-.087 (-.14- -.04)**	**.001**	-.021	-021	.415
Years same class	**-.026 (-.04- -.01)**	**-.081 (-.12- -.04)**	**.001**	-.011	-.028	.226	**-.046 (-.07- -.03)**	**-.114 (-.16- -.06)**	**.001**
Years liv together	**-.024 (-.04- -.01)**	**-.073 (-.11- -.03)**	**.001**	**-.044 (-06- -.03)**	**-.128 (-.18- -.08)**	**.001**	**-.048 (-.07- -.03)**	**-.127 (-.17- -.08)**	**.001**
Distance	.022	.052	.089	.030	.064	.063	-.034	-.070	.052
Adjusted R Square	(Sex only):.003 (Sex+contact):.016			(Sex only):.000 (Sex+contact):.028			.042		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "social inhibition and withdrawal", adjusted for gender. 95 % Confidence Intervals in parentheses.

Table 9 Effect of contact between twins on lack of reality orientation (Factor 8)

	MZ (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictors	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	.028	.025	.308	-.001	-.001	.962	-.055	-.061	.052
Personal contact	.010	.017	.599	-.012	-.022	.580	**.102 (.05-.15)**	**.164 (.08-.25)**	**.001**
Closeness	.004	.003	.880	-.020	-.021	.408	**-.067 (-.12--.01)**	**-.061 (-.11- -.01)**	**.021**
Years same class	**-.022 (-.04 - --.01)**	**-.065 (-.11- -.02)**	**.002**	-.005	-.013	.571	**-.025 (-.05--.00)**	**-.058 (-.11- -01)**	**.017**
Years liv together	**-.041 (-.05 - -.03)**	**-.120 (-.16- -.08)**	**.001**	**-.050 (-.07 - -.03)**	**-.144 (-.19- -.10)**	**.001**	**-.045 (-.07--.02)**	**-.111 (-.16- -.06)**	**.001**
Distance	**.041 (.015 - .07)**	**.093 (.03-.15)**	**.002**	**.033 (.00 - .06)**	**.071 (.00-.14)**	**.042**	-.023	-.044	.229
Adjusted R Square	(Sex only):.000 (Sex+contact):.027			(Sex only):.001 (Sex+contact):.020			.029		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "lack of reality orientation", adjusted for gender. 95 % Confidence Intervals in parentheses.

Table 10 Effect of contact between twins on emotional instability (Factor 9)

	MZ (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictors	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	**-.067 (-.12 - -.01)**	**-.056 (-.10- -.01)**	**.019**	-.022	-.023	.429	-.016	-.020	.527
Personal contact	-.027	-.043	.177	.026	.046	.244	-.014	-.024	.561
Closeness	**.065 (.01-.12)**	**.051 (.01-.09)**	**.020**	.008	.009	.731	.045	.046	.087
Years same class	**-.016 (-.03 - -.00)**	**-.045 (-.09- -.00)**	**.032**	**-.023 (-.04 - -.01)**	**-.057 (-.10- -.01)**	**.013**	-.002	-.004	.087
Years living together	**-.017 (-.03 - -.00)**	**-.047 (-.09- -.01)**	**.030**	-.002	-.005	.839	**-.024 (-.04 --.01)**	**-.066 (-.11- -.02)**	**.008**
Distance	**.036 (.00-.06)**	**.078 (.02-.14)**	**.010**	.017	.036	.288	**.044 (.01-.08)**	**.094 (.02-.17)**	**.010**
Adjusted R Square	(Sex only):.043 (Sex+contact):.053			(Sex only):.049 (Sex+contact):.055			.006		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "emotional instabilityl", adjusted for gender. 95 % Confidence Intervals in parentheses.

Table 11 Effect of contact between twins on difficulties in forming and maintaining close relationships (Factor 10)

	MZ (N=2636)			**SSDZ** (N=2070)			**OSDZ** (N=1954)		
Predictors	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**	**B**	**Beta**	**Sig**
Telephone contact	.003	.003	.911	**-.062 (-.12 - -.01)**	**-.068 (-.13- -.01)**	**.024**	**-.077 (-.13- -.03)**	**-.091 (-.15- -.03)**	**.004**
Personal contact	.008	.014	.661	.027	.048	.229	**.064 (.02-.11)**	**.110 (.03-.19)**	**.008**
Closeness	**-.051 (-.10 - -.00)**	**-.044 (-.08- -.00)**	**.046**	-.033	-.035	.170	-.049	-.048	.067
Years same class	**-.017 (-.03 - -.00)**	**-.051 (-.09- -.01)**	**.015**	-.003	-.008	.727	-.017	-.042	.085
Years liv together	**-.039 (-.05 - -.03)**	**-.120 (-.16- -.08)**	**.001**	**-.028 (-.04 - -.01)**	**-.082 (-.13- -.04)**	**.001**	**-.054 (-.07- -.04)**	**-.142 (-.19- -.09)**	**.001**
Distance	.023	.053	.081	**.034 (.03-.07)**	**.074 (.00-.14)**	**.035**	-.006	-.012	.732
Adjusted R Square	(Sex only):.003 (Sex+contact):.026			(Sex only):.000 (Sex+contact):.013			.031		

Note: MZ: monozygotic twins, SSDZ: same-sex dizygotic twins, OSDZ: opposite-sex dizygotic twins. Dependent variable "difficulties in forming and maintaining close relationships", adjusted for gender. 95 % Confidence Intervals in parentheses.

The pattern and direction of all the significant correlations for all the categories of twins (MZ, SSDZ, OSDZ, MZM, MZF, DZM, DZF) is shown in Table 12 and 13 a + b. The analyses were carried out separately for each group.

Table 12 Statistical significant beta values for the three twin groups

	Monozygotic Twins						Same Sex Dizygotic Twins						Opposite Sex Dizygotic Twins					
	Tecon	percon	Gcon	Yrscla	Yrstog	dist	Tecon	percon	Gco	Yrscla	Yrstog	dist	Tecon	Percon	Gco	Yrscla	Yrstog	dist
Depr. & anx.				***	**		(**)		*		***					*	***	
Insecurity			*		**								*				***	
Neg. emotions	(***)			***	***	*		(**)	*		***			(*)		**	***	
Social inhib.				***	***				*		***		**	(***)		***	***	
Lack of rel. or.				**	***	(**)					***	(*)		(***)	*	*	***	
Emotional inst.	*		(*)	*	*	**				*							**	(**)
Difficulties rel.			*	*	***		*				***	(*)	**	(**)			***	

Table 13 a) Statistical significant beta values, twin groups separated by sex

	Monozygotic Males						Monozygotic Females					
	Tel con	Per con	G con	Yrs cla	Yrs tog	dist	Tel con	Per con	G con	Yrs cla	Yrs tog	dist
Depr. & anx.				**						***	***	
Insecurity	*								*		***	
Neg. emotions				***	***		(***)		*		***	
Social inhib.				**						*	***	
Lack of rel. or.					***	(***)				**	***	
Emotional inst.		**				(***)				**		
Difficulties rel.	(**)	**		**	***	(*)	*	(**)	***		***	

Note: *p < .05; **p < .01; ***p < .001 (two-tailed tests). NB: All coefficients negative, except the ones in parentheses.

Table 13 b) Statistical significant beta values, twin groups separated by sex

	Dizygotic Males						Dizygotic Females					
	Tel con	Per con	G con	Yrs cla	Yrs tog	dist	Tel con	Per con	G con	Yrs cla	Yrs tog	dist
Depr. & anx.				*	*				**		***	
Insecurity			(**)			(*)						
Neg. emotions		(*)		**	***				**		**	
Social inhib.		*	**				*		*		***	
Lack of rel. or.				**		(*)					***	
Emotional inst.				***				(*)				
Difficulties rel.			(**)				*		***		***	(*)

Note: *p < .05; **p < .01; ***p < .001 (two-tailed tests). NB: All coefficients negative, except the ones in parentheses

Moderator analyses for zygosity and gender

To examine whether the effects were systematically different between the groups, the differences in effects of contact on mental health in relation to the moderator variables "*zygosity*" and "*gender*" were tested. This was tested by entering an interaction term between each of the *contact variables and zygosity* in the regression analyses. The same procedure was carried out to test gender differences. The significant interaction effects involving zygosity and gender are not tabulated, but beta values and confidence intervals are included in the text. Then the results from the *sex X contact* interaction tests were seen in relation to the results from the initial sex-separated regression analyses (the strength and direction of the correlations for males and female MZ and DZ twins).

Zygosity

MZ and DZ twin groups and the effects of contact on SCL-5 index and the personality factors: There were no significant effects (zero out of six) from the interaction contact and zygosity on symptoms of *anxiety and depression*, which means there were no significant group differences. The differences between MZ and DZ twin groups are significant only in relation to *perceived negative emotions (factor 3) (p=<.005*) (four significant *contact and zygosity* correlation out of 36 analysis). This might indicate small overall differences between MZ and DZ twins when it comes to effects of contact on mental health.

MZ and SSDZ versus OSDZ twin groups and the effects of contact on SCL-5 index and the personality factors: There were significant interaction effects (6 out of 42) related to *contact and zygosity (recoded)* on symptoms of *anxiety and depression*, and *social inhibition and withdrawal* (p=<.05).

Gender

MZ males and females and the effects of contact on SCL-5 and the personality factors: The analyses showed clearer indications of interaction effects (11 out of 42 analyses were significant) related to gender than zygosity. In relation to *contact on anxiety and depression*, only the interaction involving *years together and gender* reached significance (p=<.005). The correlation coefficient is positive and nonsignificant for MZ men (beta = .011), and negative and significant for DZ men (beta = -.087, CI = (-.16 - -.01) and MZ women (beta = -.106, CI = -.02 - -.01). *Contact and gender* had effects on *insecurities concerning self esteem and identity, social inhibition and withdrawal, lack of reality orientation, emotional instability,* and *difficulties in forming and maintaining close relationships.*

Perceived closeness is intended to measures quality of contact, and the variable most closely linked to the concept of "attachment". This is interestingly the contact measure that appears most frequently in significant interactions with *zygosity or gender*. In the DZF group, *perceived closeness* is negatively correlated with *anxiety and depression* (beta= -.093, CI = (-.15 - -.03, p=.003), *negative emotions* (beta= -.088, CI = (-.14 - -.03), p=.005), *social inhibition* (beta= -.065, CI = (-.13 - -.00), p=.037), and *difficulties in forming and maintaining close relationships* (beta= -.099, CI = (-.16 - -.04 p=.001).

In the MZF group, *perceived closeness* is negatively correlated to *insecurities in self esteem and feelings of identity* (beta= -.069, CI = (-.44 - -.01), p=.012), *negative emotions* (beta= -.069, CI = (-.12 - -.02), p=.012) and *difficulties in forming and maintaining close relationships* (beta= -.101, CI = (-.15 - -.05), p=.001). There seem to exist a different pattern for males. In the DZM group, *closeness* is positively correlated with *insecurities concerning self esteem and identity* (beta= .123, CI = (.04 - .20) p=.002) and *difficulties in forming and maintaining close relationships* (beta= .118, CI = (.39 - .20), p=.004), and negatively with *social inhibition* (beta= -.122, CI = (-.20 - .-04), p=.002).

Among MZM twins, *perceived closeness* does not seem to have any strong association with mental health, neither positive nor negative. Other potential interesting effects may be linked to *personal contact*, which correlates negatively with *emotional instability* (beta= -.146, CI = (-.3 - -.02), p=.006) and *difficulties in close relations* (beta= -.164, CI = (-.27 - -.06), p=.002) for MZM. In the three other groups, *personal contact* is positively correlated with the same factors: *emotional instability* (DZM): (beta= .107, CI = (.00 - .21), p=.042), *difficulties in close relations* (MZF): (beta= .108, CI = (.03 - .19), p=.010), as well as *negative emotions* (DZM): (beta= .138, CI = (.02 - -.26), p=.028), indicating that relational difficulties increase proportional with contact, or hypothetically that twins with difficulties in forming relationships contacts their co-twin more than twins without such problems.

DZ males and females and the effects of contact on mental health: 14 out of 42 predictors reached significance. *Perceived closeness* was negatively correlated (beta = -.093, CI = (-.15 - -.03), p=.003) to *symptoms of anxiety and depression* in the DZ female group and positively (but nonsignificant) correlated in the DZ male group. *Contact and gender* was positively related to several of the factors in the DZ male group. The effect often seemed opposite for the females, which may mean that closeness does not protect against poor mental health the same way for males as females, or that males with mental health problems seek to their sisters for support. *Perceived closeness and gender* (p=.039) and *years living together and gender* (p=.039) correlates with *perceived negative emotions.* There are negative correlations effects on *perceived closeness* (beta = -.088, CI = (-.02 - -.03), p=.005) and *years living together* (beta = -.091, CI = (-.14 - -.03), p=.003). When these forms of contact increase, *negative emotions* decrease for DZ twin females. *Personal contact and gender* (p=.044) and *years together and gender (*p=.000) is correlated with *social inhibition and withdrawal.* The effect of *years living together* is a strong predictor for this factor (beta = -.218, CI = (-.27 - -.16), p=.000) (see Table 13 a + b)

There are several significant effects of *contact and gender* on *lack of reality orientation*. This personality dimension seem to be positively related to the variable *distance* for both sexes (significant for males only, beta =.122, CI = (.02 -.23), p=.023) and *years living togethe*r (significant for females only, beta =-.198, CI = (-.25 - -.13), p=.001) is negatively related to *lack of reality orientation*. Finally, the independent moderator variables *telephone contact and gender* (p=.048), *perceived closeness and gender* (p=.000) and *years in same class and gender* (p=.002) is correlated to *difficulties in forming and maintaining close relationships*

(factor 10). The direction of the correlation shows a different pattern for males and females within the groups.

General Discussion

Twins share experiences and spend a considerable amount of time together (Rose, 2002), and are in many cases a significant and life-long source of social support and affection. Representatives from different theoretical orientations acknowledge that the quality and frequency of interactions with significant others are crucial to social and emotional development (Penninkilampi-Kerola, 2006). The present study aims to examine whether degree and quality of contact between twins is associated with subjective mental health on a representative sample of adult twins, using predictions from attachment- and evolutionary psychological theories. It is worth noting that attachment theory traditionally has been used in order to describe the relationship between a child and its caregiver, were the relationship is based on the fact that the child receives help to regulate emotions by a person who is more mature (Bowlby, 1969). The present study leans to the theory in order to describe the hypothesised importance of co-twin relationship and the effects on symptoms of anxiety and depression and personality dimensions. The results indicate an association between co-twin contact and mental health. The contact measures are (in most cases) negatively correlated with the mental health measures, which suggests that a close co-twin relationship offers a protection against symptoms of anxiety and depression, and different forms of problems related to personality dimensions.

SCL-5: The statistically significant predictors for symptoms of anxiety and depression are *years in same class* (MZ and OSDZ), *years living together* (MZ, SSDZ and OSDZ), *perceived closeness* (SSDZ) and *telephone contact* (SSDZ). All correlations, except one, are negatively correlated with the dependent variable (SCL-5), meaning that poor mental health decrease when contact increase. *Telephone contact* is, perhaps contrary to the expectation, associated with increased symptoms.

The personality factors: Years in same class and *years living together* appears to be the strongest predictors when explaining the variance in the personality dimensions linked to personality functioning. In sum, nearly all the correlations are negative, with some exceptions

(*telephone contact* and *good contact*). Overall, the results indicate that when contact increases, subjective personality functioning difficulties decreases.

Moderator effects

Few of the zygosity moderator effects reached significance, contrary to predictions from evolutionary psychological theory, the data suggests marginal group differences related to forms of contact between MZ and SSDZ twins and how it is associated with mental health. This is in line with findings in a study by Pulkkinen et al (2003), were the authors maintain that MZ and DZ twins represent the same base population, a fundamental assumption of the classic "twins method" studies. Further, a study by Kendler, Pedersen, Farahmand and Persson (1996) found that MZ versus same-sex DZ twins, or opposite-sex DZ twins did not differ significantly from unity for any of the disorders (psychotic or affective) examined. Marginal differences were also the result from the analyses of the *same- sex and opposite-sex groups (MZ and SSDZ versus OSDZ twin groups)* in the present study, and it might be discussed whether the few correlations that appeared might be artefacts of the analyses. Similar findings of nonsignificant group difference between same-sex and opposite-sex twins has been interpreted in the light of assumptions that consider the relationship between twins as unique in its characteristics, since the relationship in opposite-sex pair seem to transcend gender differences (Penninkilampi-Kerola, Moilanen & Kaprio, 2005). Anyhow, it is not at all conclusive what the few significant findings between same-sex and opposite-sex twins mean.

Gender differences were found in both zygosity groups (MZF/MZM and DZM/DZF). There were several significant moderator effects of *contact and gender* on both SCL-5 and the personality factors, suggesting that the different forms of contact and their effect on mental health differs in relation to gender of the co-twin. This is reflected in some of the predictors, which have positive correlations for girls and negative for boys, or the other way around. In sum, the overall effects seem stronger for girls. It is worth noting that some of the variables may have reached significance on chance, so the results must be interpreted with caution. On the other hand, significance moderator effects appear frequent enough to indicate that there exist actual differences between the twin groups according to gender when it comes to co-twin contact and the effects on symptoms and personality dimensions. These findings suggest that gender has mediating effects on several of the measures. Penninkilampi-Kerola and colleagues (2005) suggests that gender differences between twins and/or they rapports of the

co-twin relationship may be understood in light of previous studies of gender roles, that conclude that females often are more attuned and more sensitive relationships, and more likely to express feelings of closeness and affection compared to males.

Statistical significance versus practical significance

Though statistically significant, the size of the correlation coefficients might not seem very large. It is quite usual to find significant predictors with such large samples, and only a limited amount of the variance in mental health can be explained by the relationship measures. The age and life-face of the respondents may partly explain the relatively low overall effect. Twins, like everybody else, have a hierarchy of attachment relationships who might change throughout life. The co-twin usually shares the top of the hierarchy with others, for instance partner and friends (Tancredy & Fraley, 2006). Neyer (2002) maintains that twin relationships may tend to form a U-shaped curve of development on sibling relationships throughout life. The twins, as well as other siblings, may withdraw from the other in early adulthood because of different commitments related to partner, family and work. After reproductive age they may re-intensify their relationship with their twin, now favoured over less emotionally close relations. It may be possible that the results might turn out differently for our sample if they were re-measured in an older age than young adulthood.

Even though there are a number of different indicators for the co-twin contact who reaches statistical significance, the error margins makes it difficult to interpret which of the contact measures that is most important when it comes to practical significance. When interpreting the practical relevance versus the statistical significance of the findings, it is important to consider the sum of years involved, and in this case the b values can add information in addition to the beta values. An example: the effect for MZ females on the predictor *years in same class* is b = -.049 (CI = -.083 - -.032). This may seem little for a year, but on a period of 10 years (duration of primary and secondary school in Norway) in class together, the twins gets nearly 60 % of one standard deviation less symptoms of anxiety and depression compared to twins who has not attended the same class. Further, the effects of *perceived closeness* (b = -.131, CI = -.200 - -.062) on *difficulties in forming and maintaining close relationships* means 13 % of one standard deviation unit increase on a four point scale, and it can be argued that effects of this size has an this impact when the effect is accumulated through years together.

In sum, the results from the present study partly support the research hypothesis derived from the psychological theories. In addition, the findings contradict the psychopathological hypothesis mentioned in the introduction, which has been prominent in decades of casuistic research on twins, and who claims that extensive contact between twins has disadvantages that often will manifest themselves in psychological dysfunctions.

Methodological considerations

A well known limitation of the regression models is the *direction of causality*-issue. In the present study, assumptions about the causal link are derived from attachment and evolutionary psychological theory, which states that a close and supportive twin relationship protects against mental health problems. In addition to theoretical hypothesis, the assumed direction is supported by some of the findings. The strongest overall predictors are *years living together* and *years in same class*. This indicates that shared experiences from school and family life, i.e. contact that to a certain degree lies outside the twin's control, has the largest impact on their mental health scores. This might suggest that (close) contact leads to mental health benefits. However, the cause and effect may also exist the other way around, twins with a good mental health may be able to develop and maintain a closer co-twin relationship than twins with a poor mental health. A reversed causality direction might be a positive one, suggesting that good mental health leads to contact, or a negative one, suggesting that poor mental health leads to contact. The notion that twins with mental health problems or personality issues might be in need of frequent contact with their twin, and that this need leads to increased co-twin contact, may explain why the variables *personal contact, distance* and *telephone contact* are positively correlated with some of the mental health measures. For the twin to come visit, phone and/or move closer to their co-twin when depressed, anxious or insecure, might seem intuitively natural, and perhaps in accordance with attachment theory. The need for contact may be interpreted as behaviour comparable to the features of an attachment relationship – proximity seeking and maintenance, safe haven and secure base, and might to some extent explain the positive correlation between *perceived closeness* and *insecurities related to self esteem and identity* in for instance DZ males – unconfident men may seek to their sisters for contact instead of friend or others.

The issue of causality is also addressed in a similar study by Paluszny et al (1977), who investigated twin closeness and its relation with depression through self-rated questionnaires, and found a negative correlation between the two variables. The authors assumed that the

correlation between feeling close to the co-twin and low levels of depression might suggest a causal relationship between the two phenomena, meaning that feeling of closeness decreases depression, or that the experience of depression can alienate a person from their significant other.

Moreover, another limitation of the study is the risk of confounding variables. It is of course not solely the co-twin who has an effect on a twin's mental health, and a variety of factors on many levels may operate together and separately to shape the person's life course and psychological functioning. Large differences in the dominance/submissiveness balance in the relationships between twins may have an effect on their mental health (Torgersen, 2004; Ebeling, Porkka, Penninkilampi-Kerola, Berg, Jarvi & Moilanen), a phenomena which has been focused upon in case studies of twins within psychodynamic theories (Lawrence, 2005; Lewin, 2004; Dimitrovsky, 1989; Ainslie, 1985; Karpman, 1951) or other approaches (Ebeling et al, 2003; Moilanen & Ebeling, 1998). Effects of an imbalance in dominance and submissiveness might function as a potential confounding variable, affecting both the independent (contact) and dependent (mental health) variable. On the other hand, the dominance-submissiveness balance seems to vary across situations and domains within twin pairs (Penninkilampi-Kerola, 2006; Trias, 2006).

Practical implications

Perhaps founded in *the psychopathological hypothesis* prominent in early casuistic research on relationship between twins, there has been an ongoing debate whether twins should attend the same class or not, and parents have been advised to place their twins into different classes to avoid development of dependency both in and outside the classroom. The data presented in this study indicate that twins regardless of zygosity benefit from attending the same class, and MZ, SSDZ and OSDZ twins should probably be given the opportunity to spend time together and share experiences according to their own need of contact with each other.

Conclusion

In accordance with predictions obtained from attachment and evolutionary psychological theory, the degree and quality of the co-twin relationship seem to have significant importance for twins' mental health. The data supports the hypothesis that a close co-twin relationship offers a protection against mental health problems, meaning that the measures of the co-twin relationship predict good mental health through inverse correlations on ratings of anxiety and

depression. In addition, several of the measures of the co-twin relationship predict personality functioning measured through personality factors. Contrary to expectations from evolutionary psychological theory, few significant group differences regarding zygosity were found. Further, the gender differences which was discovered implies that whether one have a male or a female as a co-twin may possibly mediate the effects of contact on mental health. The theoretical models and existing research provides a frame of reference in attempt to interpret the findings, but even though there seem to be an association between co-twin relationship and mental health, and the research hypothesis has gained some support, this study has merely described the correlations without explaining the dynamics behind the findings. Even though this study supports predictions derived from theory, it is difficult to establish support for the attachment model and/or evolutionary psychological models relation to the understanding of twins. Consequently, more research focusing on explaining the dynamics and gender differences in co-twin relationship in association with these particular theories is needed.

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